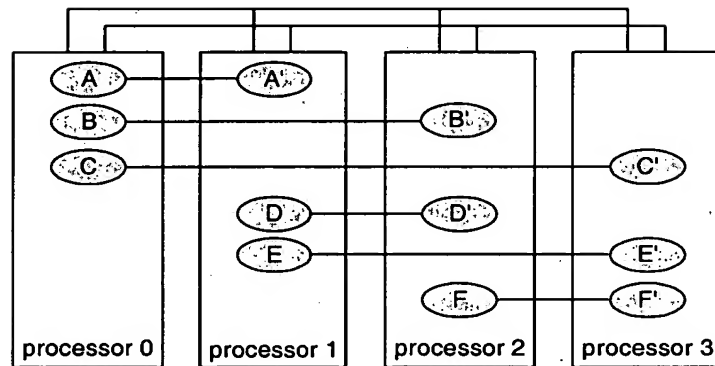


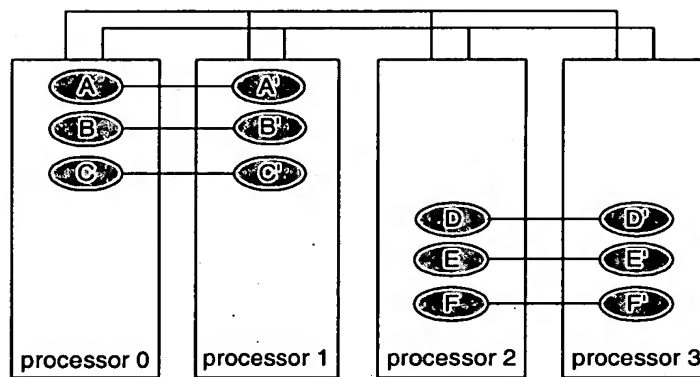
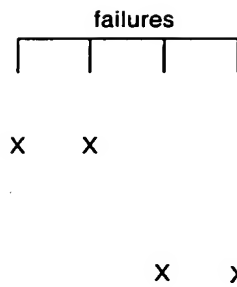
failures			
X	X		
X		X	
X			X
	X	X	
	X		X
		X	X



Any pair of processor failures causes a system failure

System Failure Modes

Figure 1

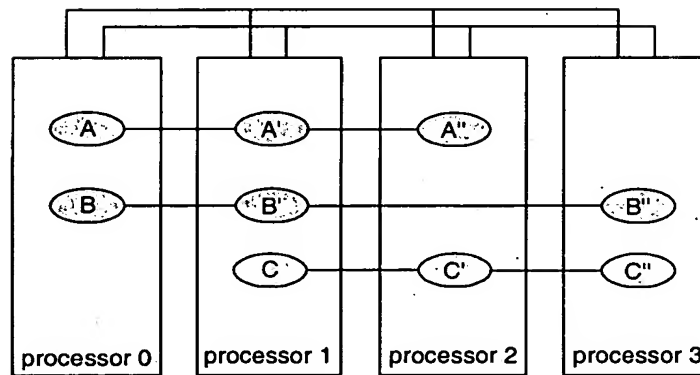


Only certain pairs of processor failures cause a system failure

Process Pairing

Figure 2

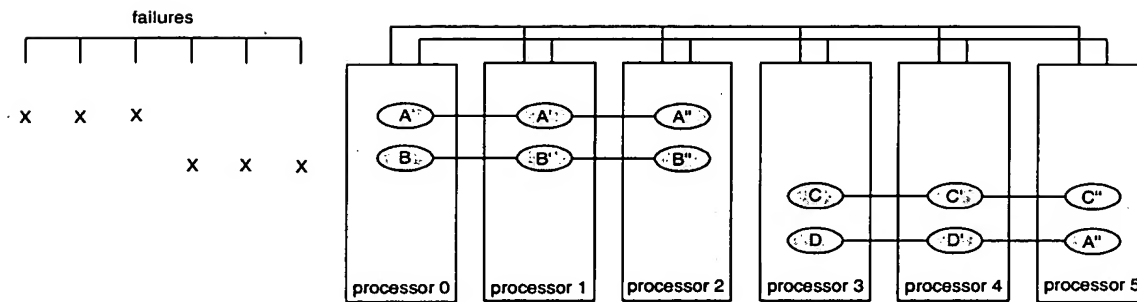
failures			
X	X	X	
X	X		X
	X	X	X



Three processors must fail to cause a system failure

Double Sparing

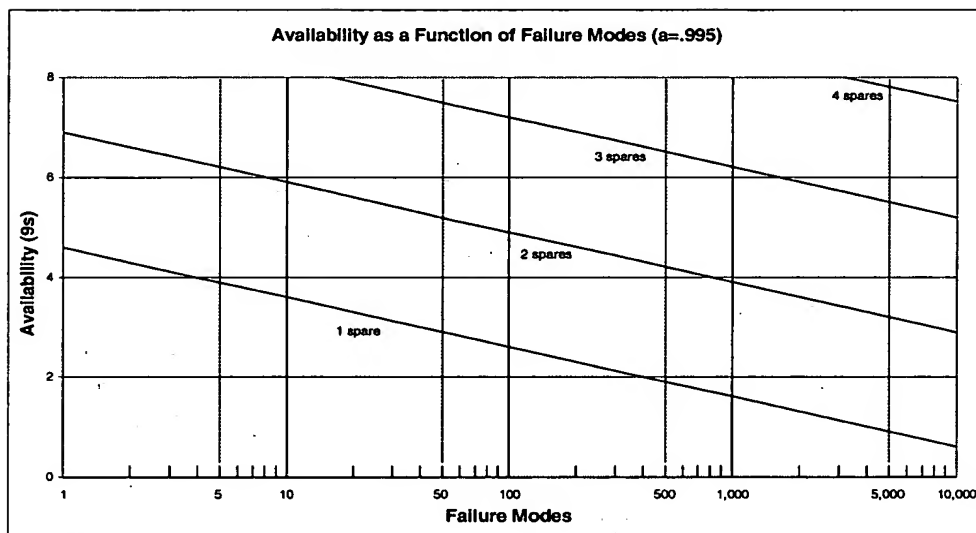
Figure 3a



Only certain groupings of three processor failures cause a system failure

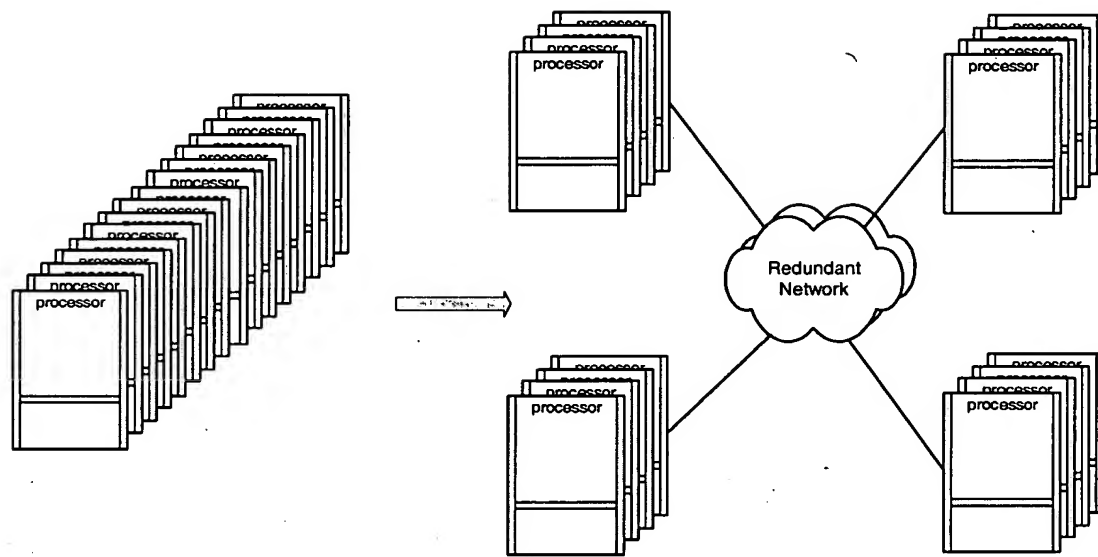
Process Tupling

Figure 3b



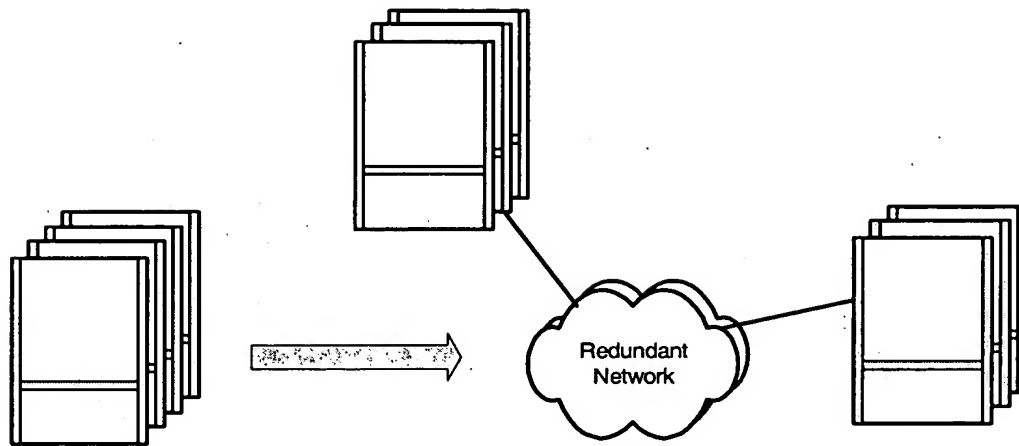
Failure Mode Impact on Availability

Figure 4



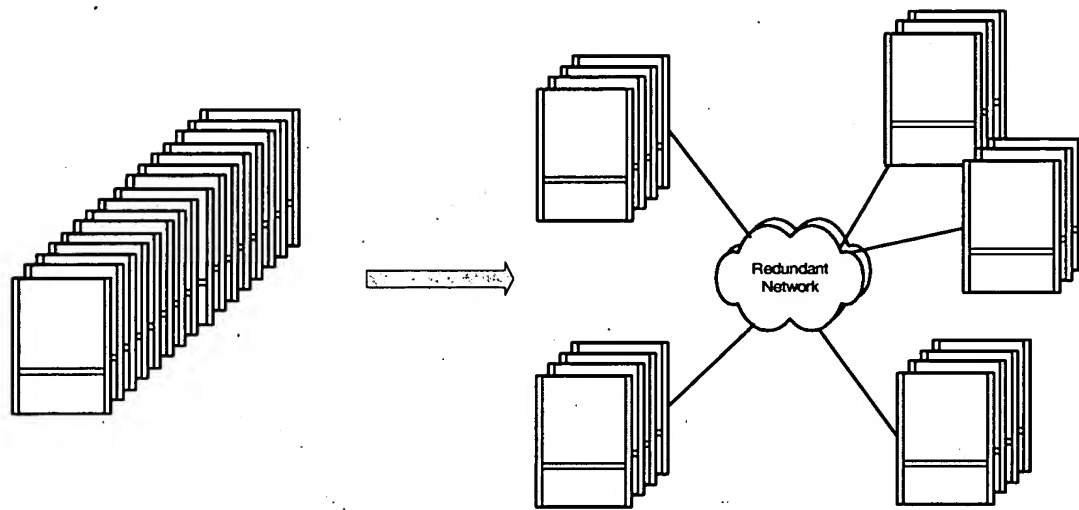
System Splitting

Figure 5a



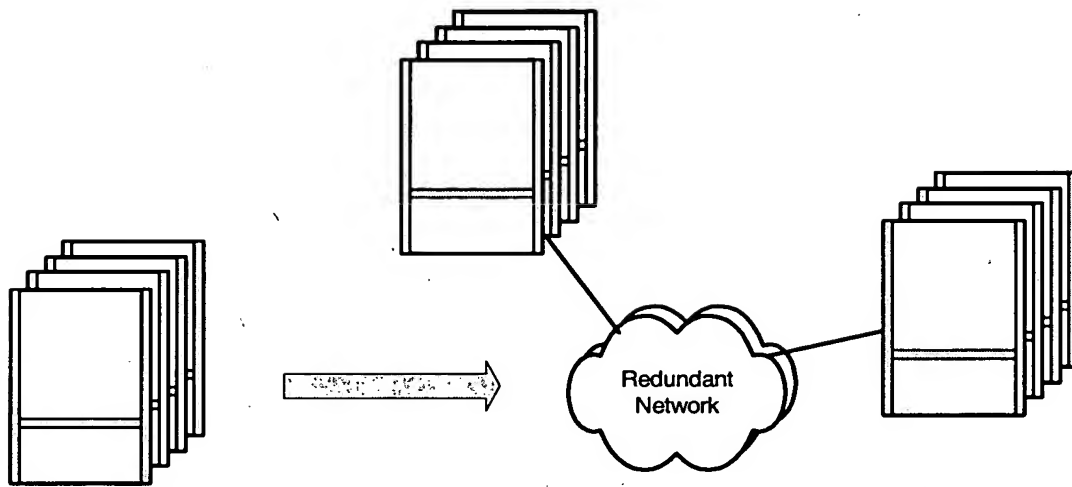
System Splitting with Capacity Enhancement

Figure 5b



Node Splitting

Figure 5c



System Splitting with Full Redundancy

Figure 5d

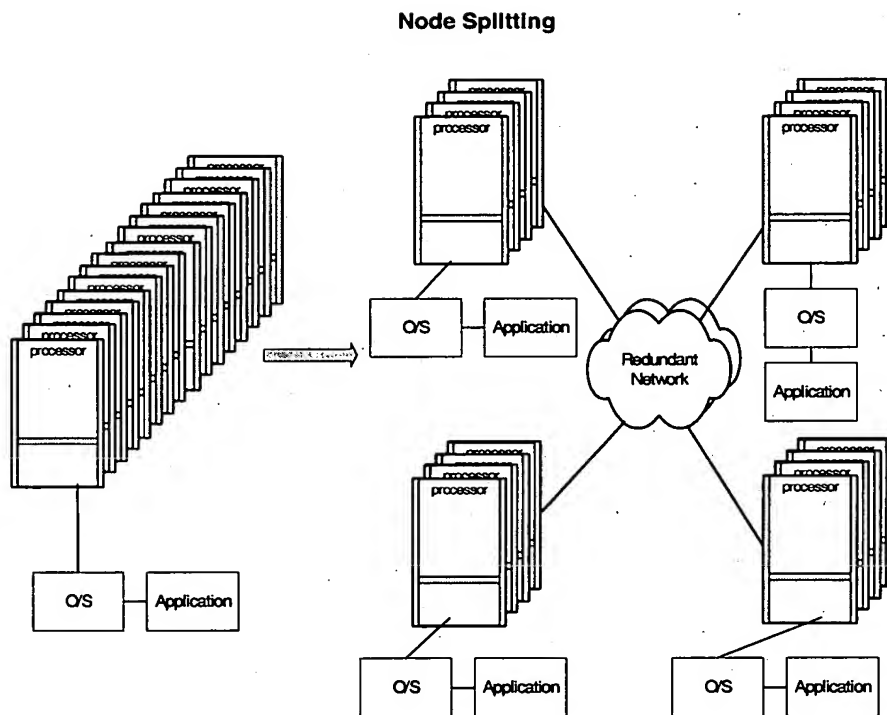
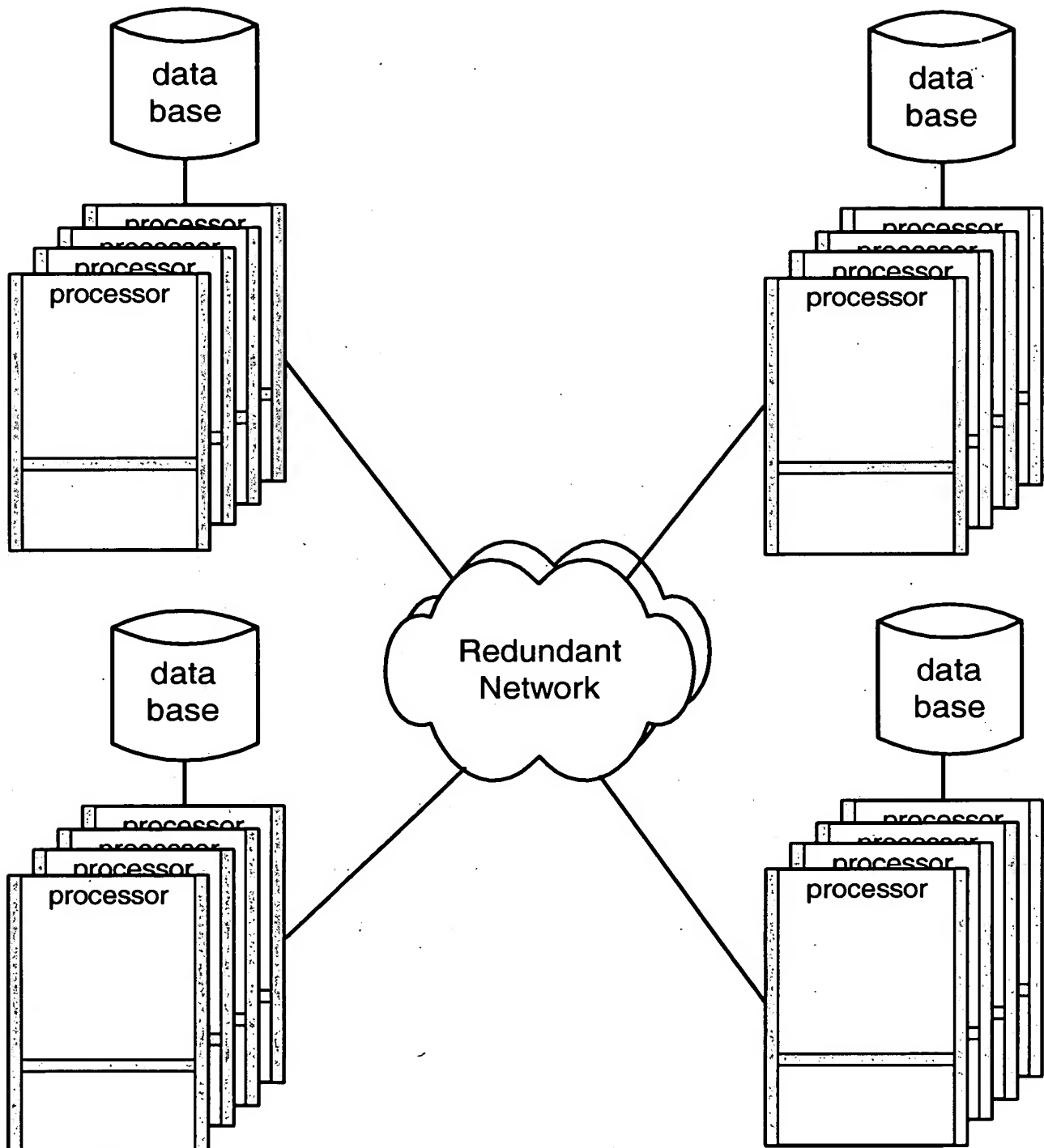
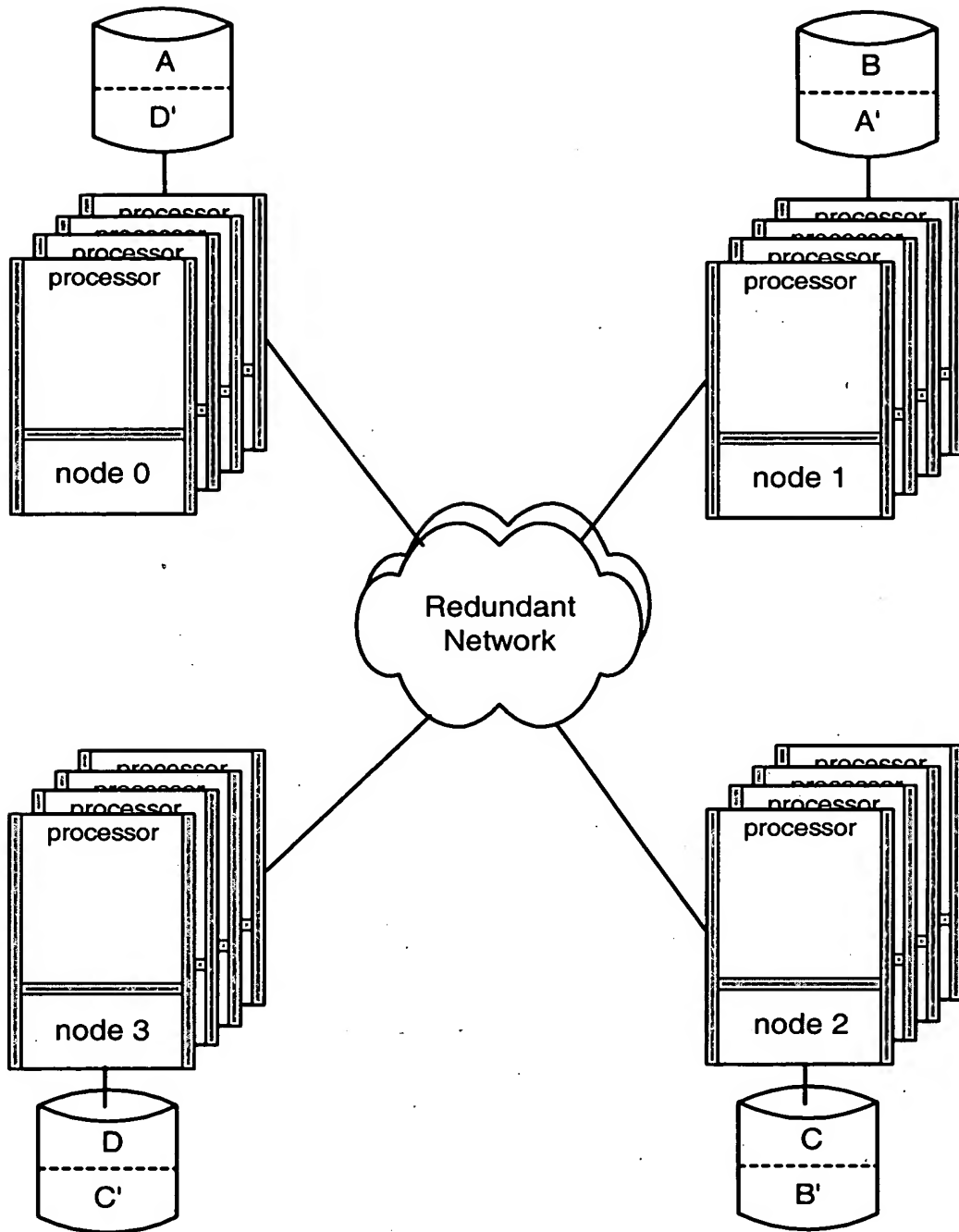


Figure 5e



Database on All Nodes

Figur 6



Partitioned Database

Figure 7

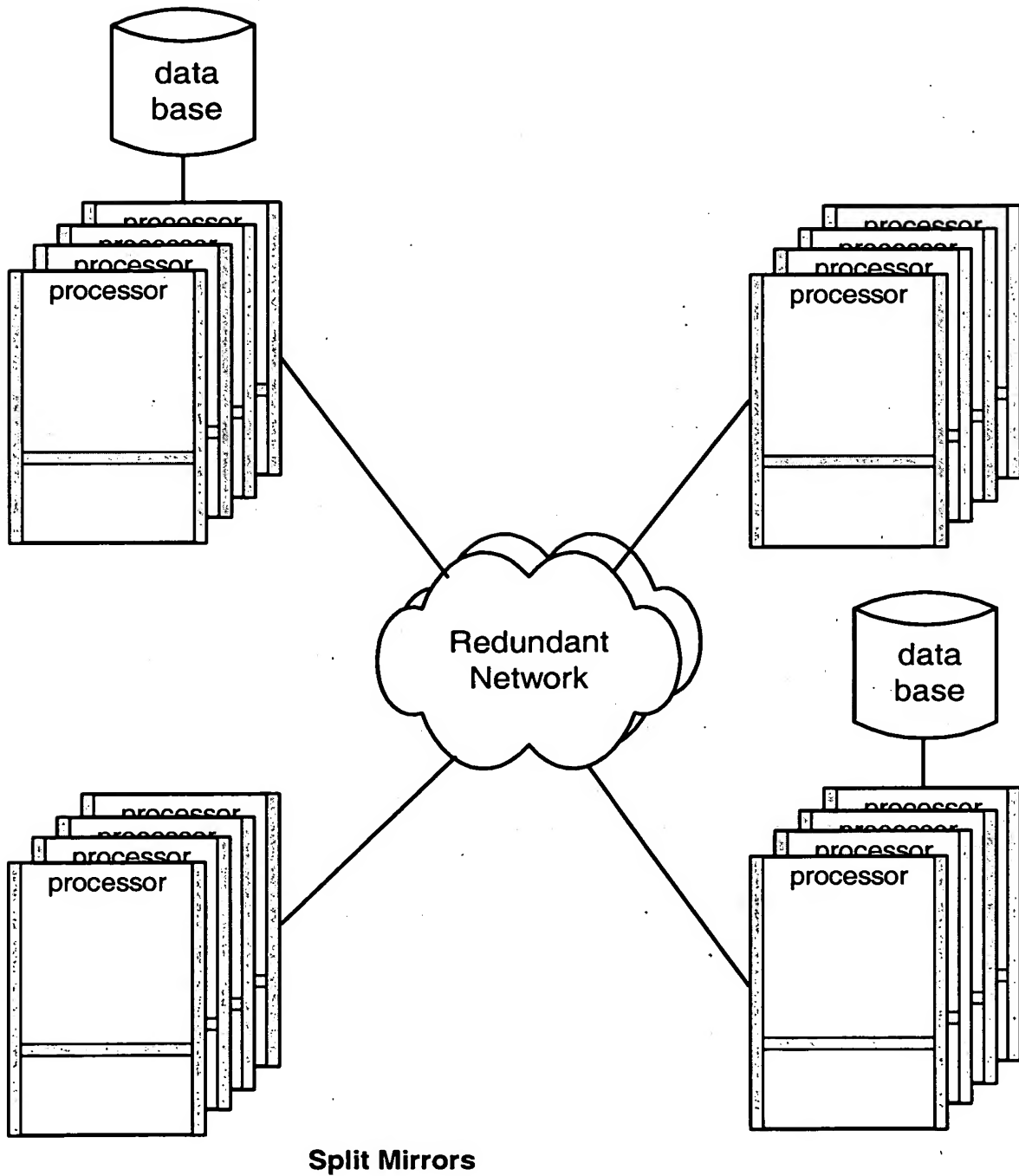
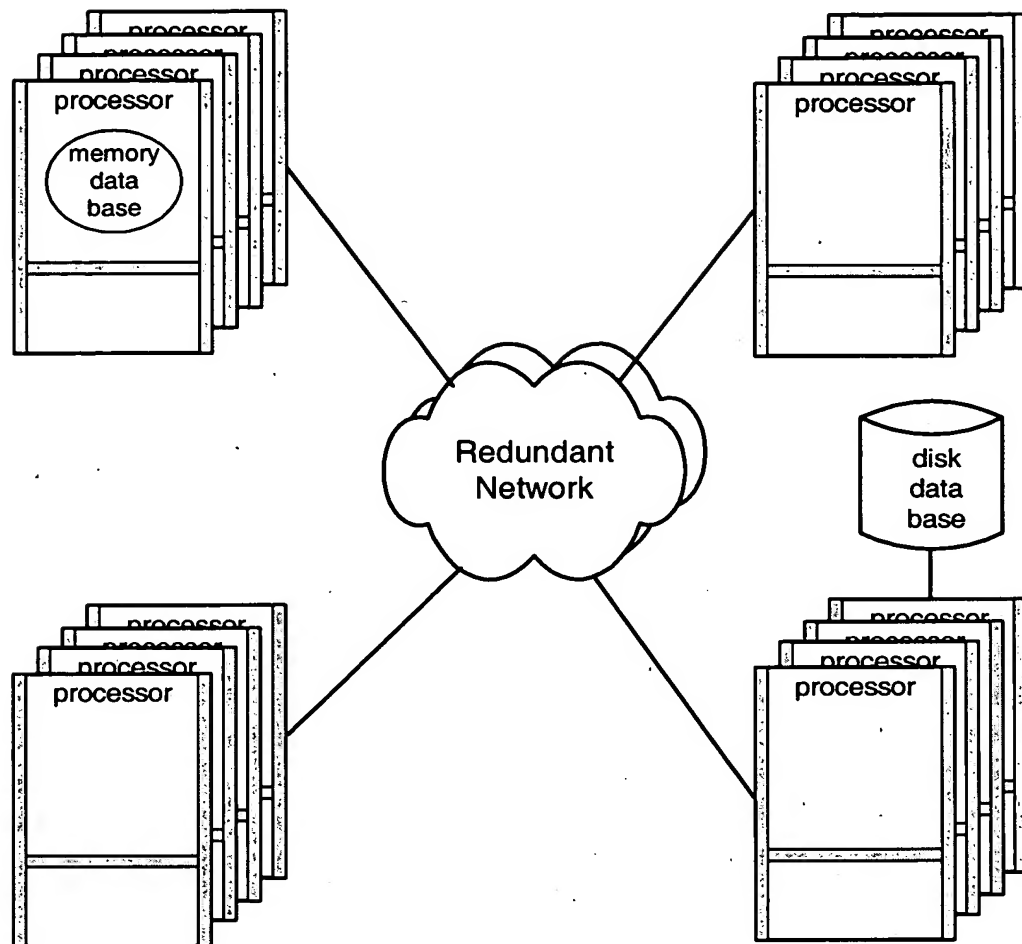
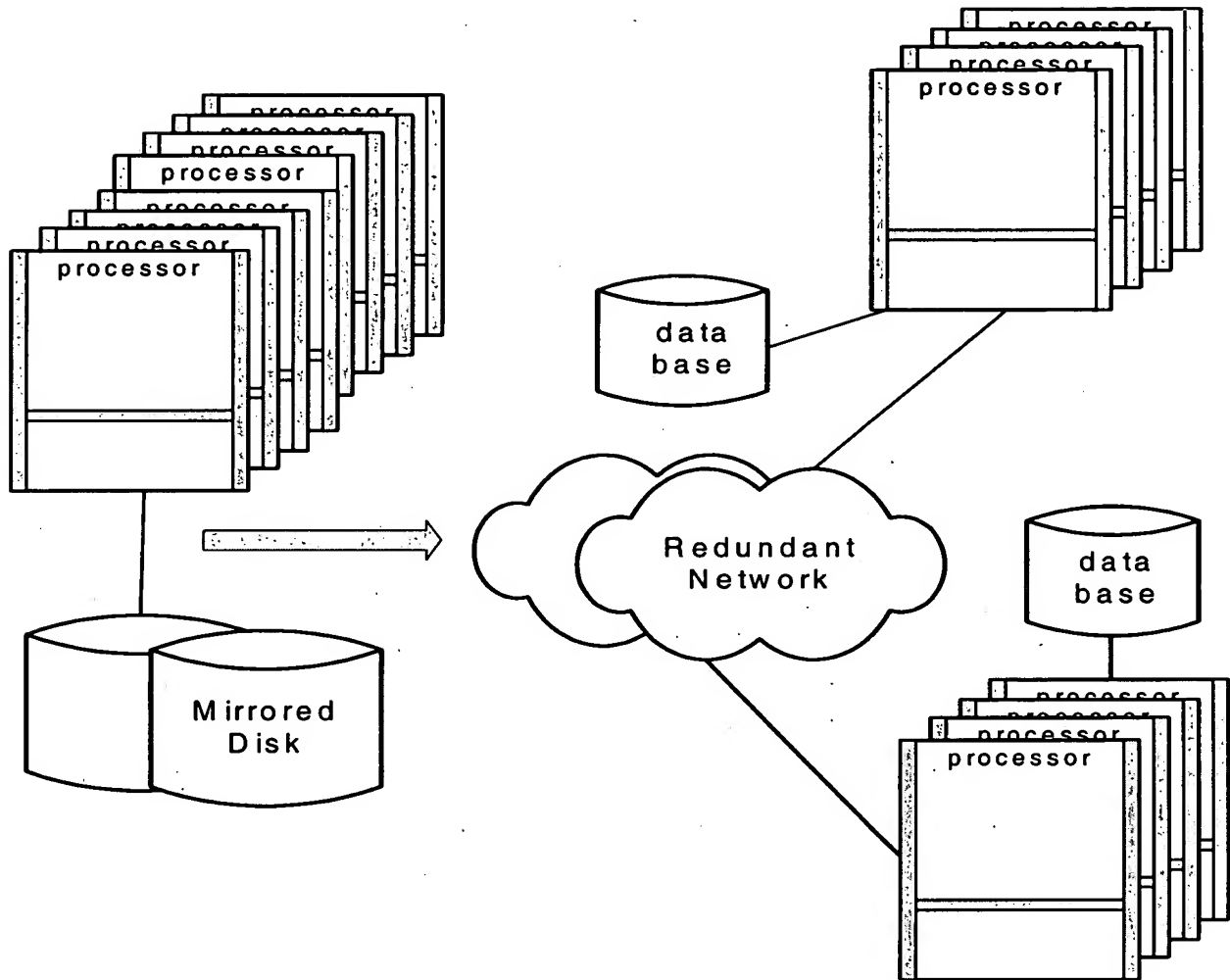


Figure 8a



Split Mirrors with Multiple Storage Media

Figure 8b



Splitting Mirrors

Figur 8c

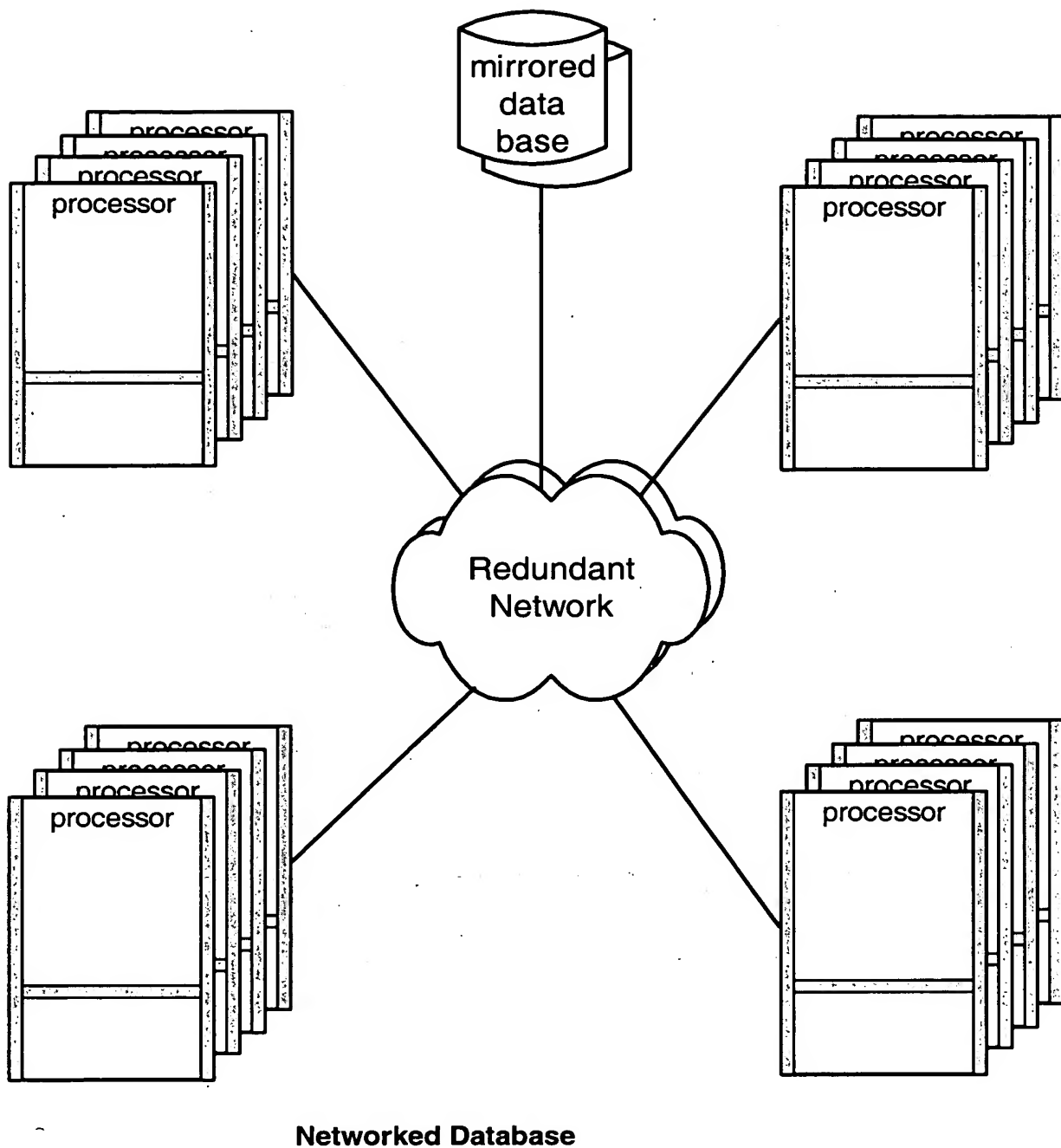
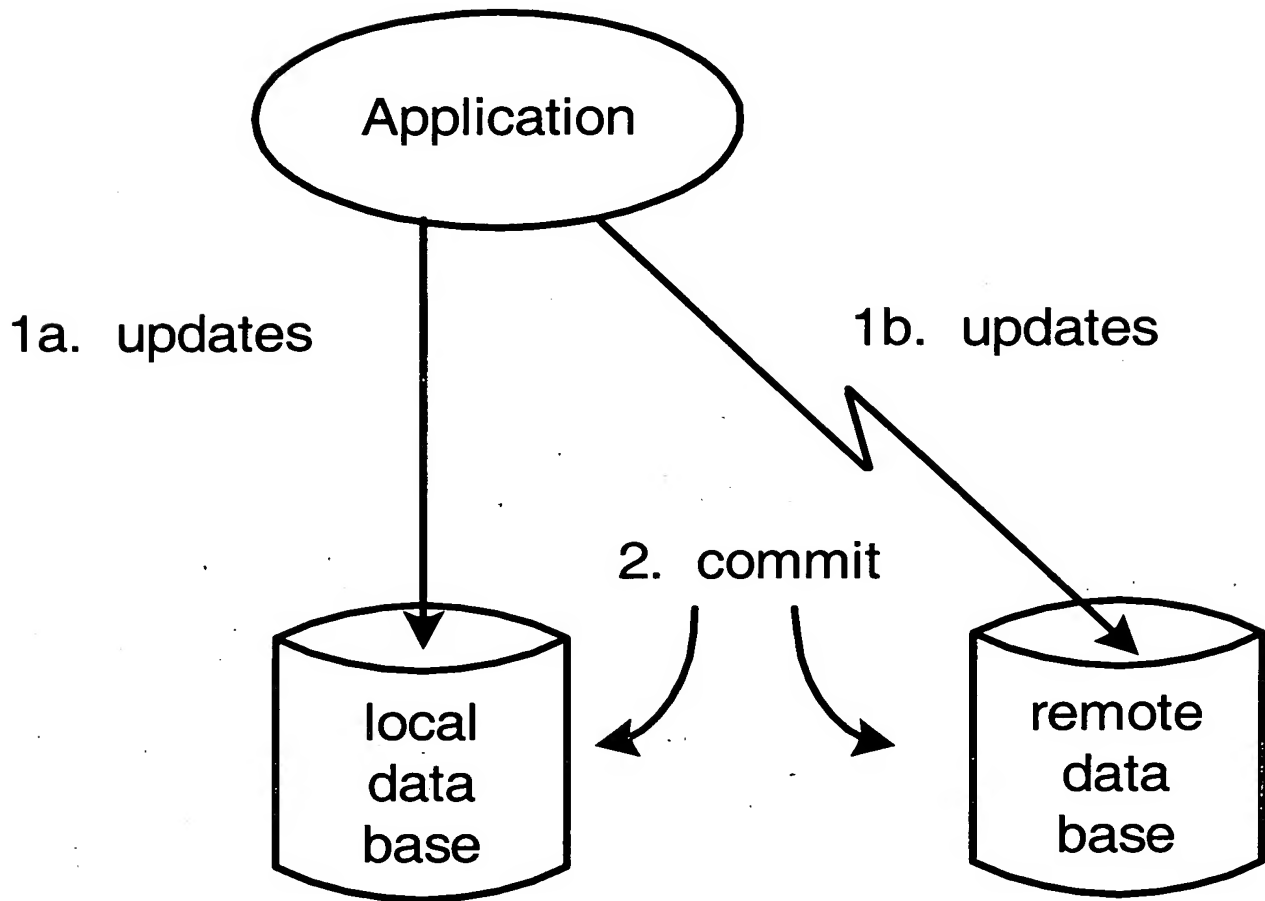
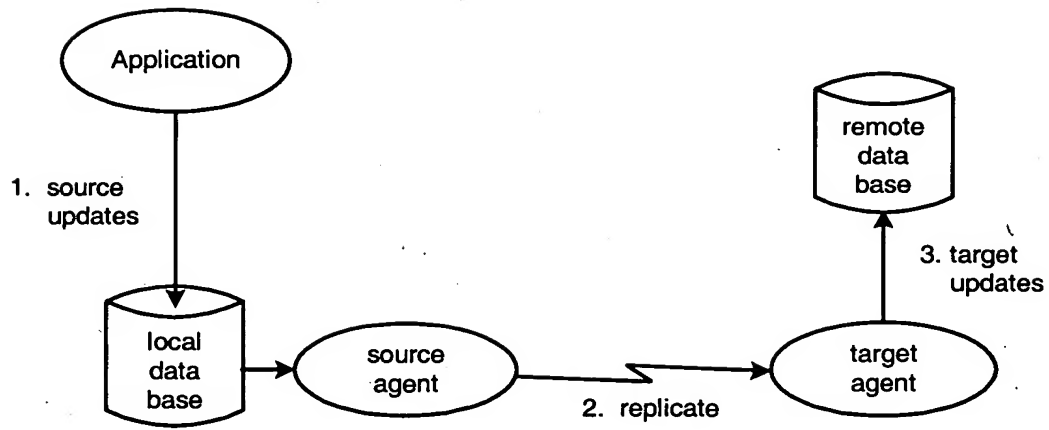


Figure 9



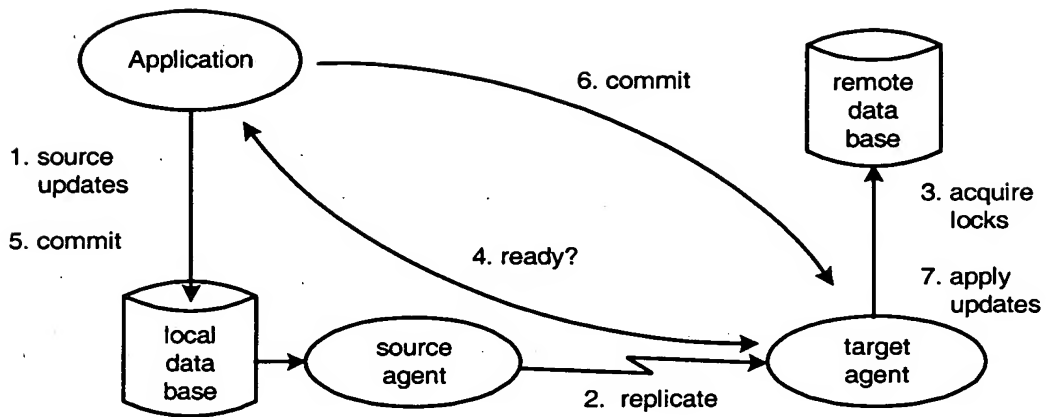
Dual Writes

Figure 10



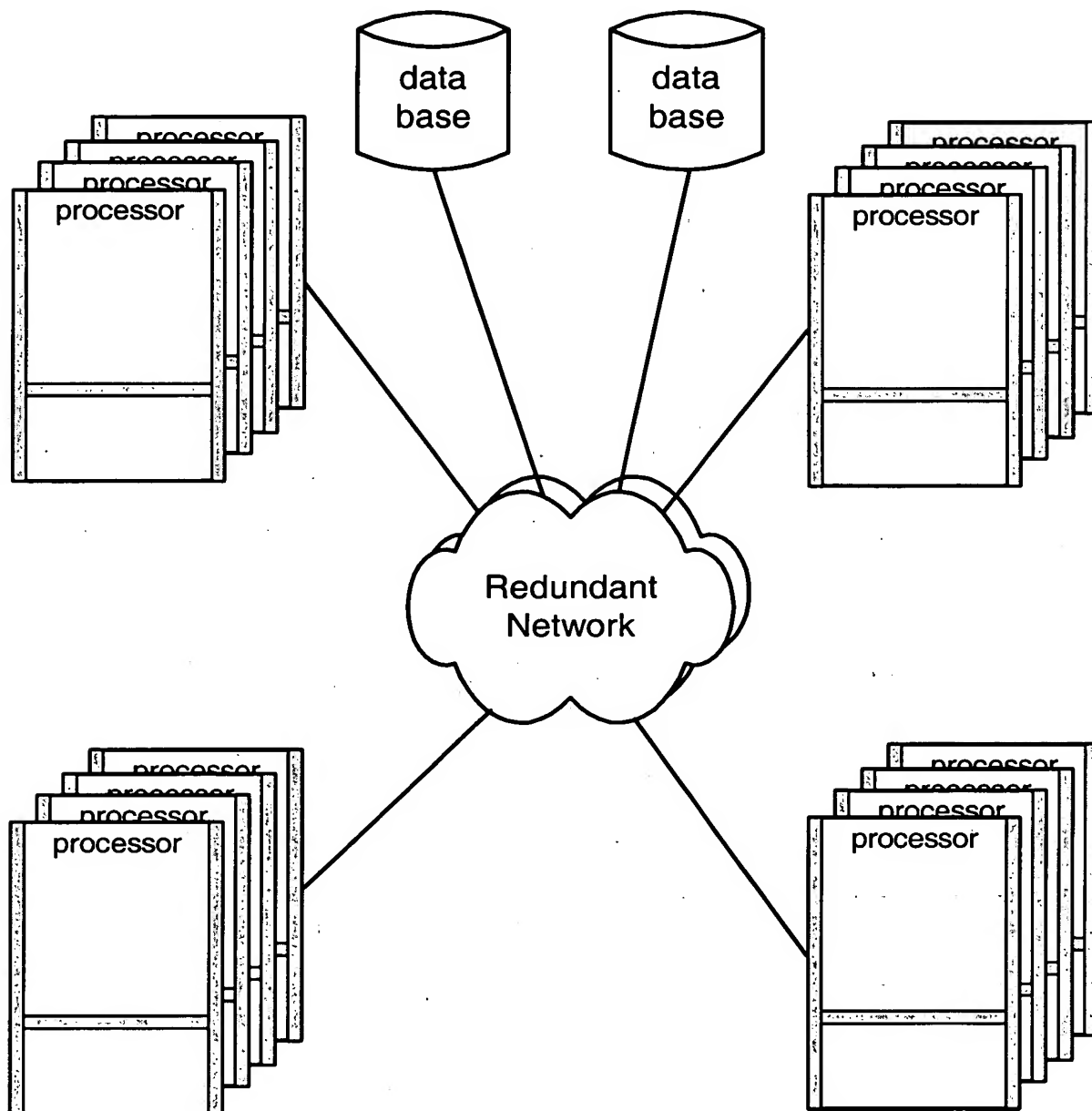
Asynchronous Data Replication

Figure 11



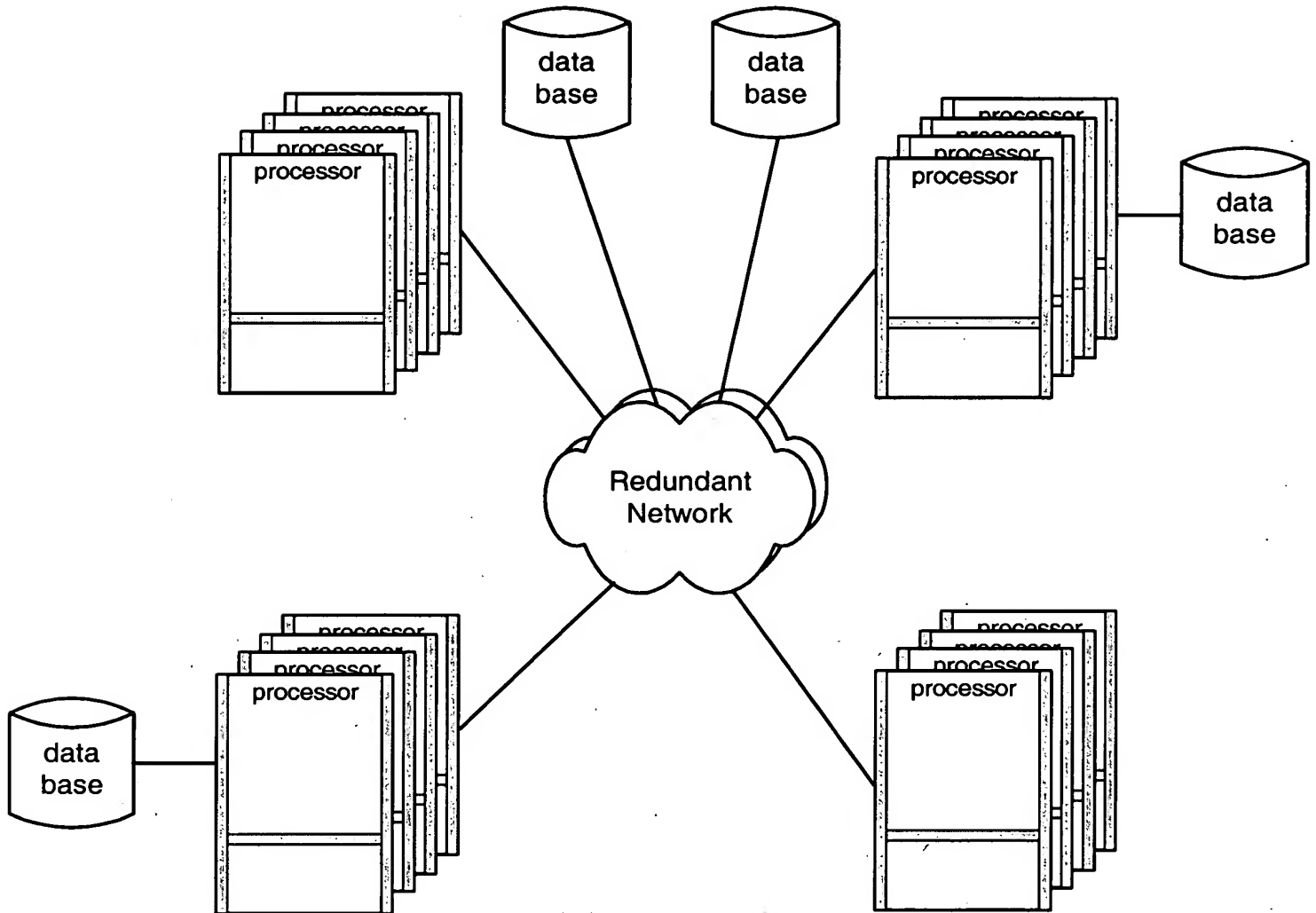
Synchronous Data Replication

Figure 12



Distributed Network Storage

Figure 13



Fully Configured Split System

Figure 14

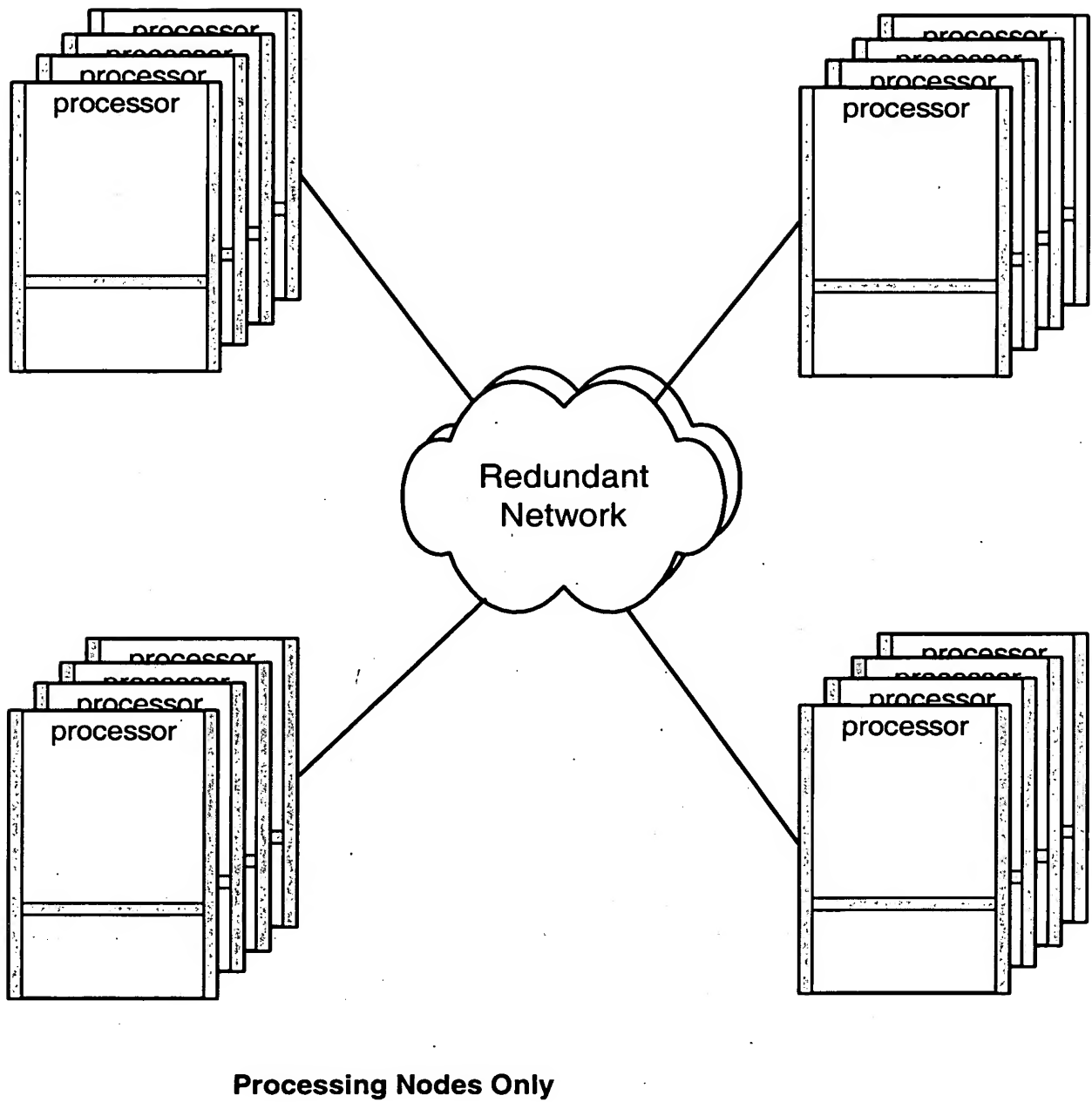


Figure 15

n	i	comb (n,i)	mode probability	s	A	F	approx F	% error (approx F high if > 0)
2	0	1	0.990025					
2	1	2	0.00995	0	0.990025	0.009975	0.01	0.25
2	2	1	0.000025	1	0.999975	0.000025	0.000025	0.00
4	0	1	0.980149501					
4	1	4	0.019701498	0	0.98015	0.019850499	0.02	0.75
4	2	6	0.000148504	1	0.999851	0.000149002	0.00015	0.67
4	3	4	4.975E-07	2	1	4.98125E-07	5E-07	0.38
4	4	1	6.25E-10	3	1	6.25E-10	6.25E-10	0.00
8	0	1	0.960693044					
8	1	8	0.038620826	0	0.960693	0.039306956	0.04	1.76
8	2	28	0.000679261	1	0.999314	0.000686131	0.0007	2.02
8	3	56	6.82674E-06	2	0.999993	6.8698E-06	7E-06	1.90
8	4	70	4.28815E-08	3	1	4.30544E-08	4.375E-08	1.62
8	5	56	1.72388E-10	4	1	1.72822E-10	1.75E-10	1.26
8	6	28	4.33136E-13	5	1	4.33758E-13	4.375E-13	0.86
8	7	8	6.21875E-16	6	1	6.22266E-16	6.25E-16	0.44
8	8	1	3.90625E-19	7	1	3.90625E-19	3.906E-19	0.00
16	0	1	0.922931124					
16	1	16	0.074205518	0	0.922931	0.077068876	0.08	3.80
16	2	120	0.00279669	1	0.997137	0.002863359	0.003	4.77
16	3	560	6.5584E-05	2	0.999933	6.66682E-05	7E-05	5.00
16	4	1820	1.0711E-06	3	0.999999	1.08413E-06	1.138E-06	4.92
16	5	4368	1.29177E-08	4	1	1.30376E-08	1.365E-08	4.70
16	6	8008	1.19008E-10	5	1	1.19867E-10	1.251E-10	4.39
16	7	11440	8.54326E-13	6	1	8.59178E-13	8.938E-13	4.02
16	8	12870	4.82973E-15	7	1	4.85138E-15	5.027E-15	3.63
16	9	11440	2.15734E-17	8	1	2.16494E-17	2.234E-17	3.21
b16	10	8008	7.58862E-20	9	1	7.60946E-20	7.82E-20	2.77
16	11	4368	2.08002E-22	10	1	2.08438E-22	2.133E-22	2.32
16	12	1820	4.35516E-25	11	1	4.3619E-25	4.443E-25	1.87
16	13	560	6.73391E-28	12	1	6.74117E-28	6.836E-28	1.41
16	14	120	7.25116E-31	13	1	7.25602E-31	7.324E-31	0.94
16	15	16	4.8584E-34	14	1	4.85992E-34	4.883E-34	0.47
16	16	1	1.52588E-37	15	1	1.52588E-37	1.526E-37	0.00

Availability Approximation (a = .995)

Table A-1

Figur 16